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February 09, 2005

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APPLICATION NUMBER: ***60/536,731***
FILING DATE: ***January 16, 2004***
RELATED PCT APPLICATION NUMBER: ***PCT/US05/01254***

UNITED STATES PATENT AND TRADEMARK OFFICE · DEPARTMENT OF COMMERCE

Certified by

Jon W. Dudas

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(b)(2).

INVENTOR(s)/APPLICANT(s)		
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☐ Additional inventors are being named on the separately numbered sheets attached hereto.

TITLE OF THE INVENTION (280 characters max)

LPG/NGL (C2+) RECOVERY PROCESS FROM LNG - GAS CONDITIONING PROCESS

CORRESPONDENCE ADDRESS

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* [10]
☐ Drawing(s) *Number of Sheets* [ ]
☐ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number ____
☐ Other *(specify)* ____

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☐ Applicant claims small entity status. See 37 CFR 1.27
☒ A check or money order is enclosed to cover the filing fee
☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 02-2135
☐ Payment by credit card. Form PTO-2038 is attached.

Filing Fee Amount: $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ____

Respectfully submitted,

SIGNATURE ____ Date January 16, 2004

TYPED or PRINTED NAME G orge R. Repp r
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REGISTRATION NO. 31,414
Docket Number: 3067-103

USE ONLY FOR FILING PROVISIONAL APPLICATION FOR PATENT

LPG/NGL (C2+) Recov ry Pr c ss from LNG – Gas Conditioning Process

Prior rec rds of related reference Patent and Literature:

Related Patents

1. Patent Number 2,952,984 (September 20, 1960) - Processing Liquefied Natural Gas; Walton H. Marshall, Jr., Downings, Va., assignor, by mesne assignments, to Conch International Methane Limited, a corporation of the Bahamas. A process for efficiently separating methane from a liquefied gas with a minimum of equipment and cost.

2. Patent Number 3,837,172 (September 24, 1974) – Processing Liquefied Natural Gas To Deliver Methane – Enriched Gas At High Pressure, Inventors Stephen J. Markbreiter and Edison Irving Weiss, Brooklyn, N.Y., Assignee –Synergistic Services Inc., New York, N.Y. A process for separating ethane and heavier hydrocarbons from liquefied natural gas (LNG) to yield methane-enriched gas of predetermined heating value.

3. Patent Number 5,114,451 (May 19, 1992) – Liquefied Natural Gas Processing, Inventors C.L. Rombo, John D. Wilkinson and Hank M. Hudson of Midland, Texas, assignee – Elcor Corporation, Dallas, Texas. A process for recovery of ethane, ethylene, propane, propylene and heavier from a liquefied natural gas (LNG) stream.

Related Publications

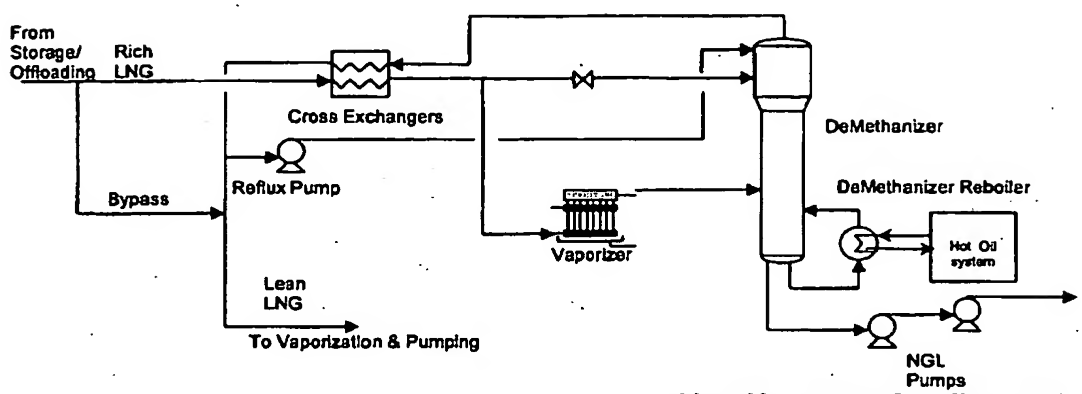
4. "A Cost Effective Design For Reducing C_2 and C_3 at LNG receiving Terminals, by C.C. Yang, A. Kaplan and Z. Huang of Foster Wheeler USA Corporation, 2020 Dairy Ashford Road, Houston, Texas 77077. Published at AIChE and Oil & Gas Journal. (May have been applied for patent application). A cost effective method described involve a small amount of additional facilities not normally existing at receiving terminals to reduce C_2 and C_3 content to meet export gas at LNG terminals.

5. Gas Conditioning for Imported LNG, by Dan McCartney, Black and Veatch Pritchard, Inc. Overland Park, Kansas, U.S.A. Published at 82nd Annual Convention, Gas Processors Association, San Antonio, Texas. An energy efficient process for BTU control to high ethane recovery requiring very little incremental energy when compared to typical requirements.

Aker Kvaerner Developed Process

The process developed by Aker Kvaerner is described below. Various alternative methods have been investigated. The new process is highly energy efficient, economical and can be integrated easily with traditional LNG terminal. It is designed to easily integrate in the LNG terminal to recover desired level of ethane, propane and heavier hydrocarbons to meet the desired export gas BTU requirements. The process is designed for high ethane recovery or very low ethane recovery while maintaining high propane plus recovery from LNG to meet export gas BTU requirements. It utilizes traditional vaporizers for heating requirements. No compression is required making it ideal for LNG Terminal application. A detailed process description and claims are to be developed. See a list of suggested claims at the end of the description.

LPG/NGL Recovery from LNG - Gas Conditioning Unit



Aker Kvaerner Confidential

LNG (rich LNG) as received is a mixture of methane, ethane, propane, and heavier components. The rich LNG enters the unit at approximately -250F. This mixture is mostly methane but has a Gross Heating Value (GHV) which exceeds the sales gas specification. Therefore, some of the ethane plus heavier compounds must the removed from the rich LNG. These heavier compounds are removed in the Gas Conditioning Unit.

The Gas Conditioning Unit is a fractionation or distillation unit which fractionates propane and heavier compounds and recovers a large portion of the ethane contained in the rich LNG.

The Gas Conditioning Unit as shown above contains cross exchangers, a vaporizer, a Demethanizer (distillation column), a reboiler, and pumps. The Demethanizer has three feed streams and two product streams. The top feed stream is the columns' reflux stream and is all liquid. The middle feed stream is the column's primary feed stream and is all liquid. The bottom feed stream is column's secondary feed stream and is preheated. The top product stream is all vapor and mostly methane. The bottom product stream is a mixture of ethane and heavier compounds (NGL) fractionated from the rich LNG.

Rich LNG from storage is pumped through the cross exchangers and split into two streams. The top stream (primary column feed) enters the column at -129F. The other stream (secondary column feed) is heated to 40F using vaporizer and enters the Demethanizer about half way down the column. The vaporizer's heat source is sea water.

The cross exchangers condense the DeMethanizer's overhead stream (lean LNG) and preheats the rich LNG going to the Demethanizer which reduces column reboiler duty (i.e. Hot Oil System capacity) and Vaporizer heat duty. Part of the lean LNG stream at -141F is returned to the top of the Demethanizer as reflux increasing propane recovery while reducing the ethane removed. The remaining lean LNG then mixes with the rich LNG bypassing the Gas Conditioning Unit and the combined stream flows to pumping and Vaporization.

The Demethanizer is a trayed column utilizing approximately 30 trays. The Demethanizer fractionates the ethane, propane and heavier components from the methane and lighter components in the rich LNG. The lean overhead vapor stream containing mostly methane exits the Demethanizer at -121F. The bottom product stream mostly containing ethane, propane and heavier components exit the column at 96F. The bottom product is controlled by heat input to the reboiler to meet Y-grade methane specifications.

The NGL from the Demethanizer is pumped to NGL pipeline pressure and enters the NGL pipeline. Two pumps in series are used (one booster and one high pressure pump) since the NGL is at its boiling point when leaving the Demethanizer. The first pump provides the NPSH required by the high pressure pump.

Suggested List of claims:

1. Efficient and economical process for separating ethane, propane and heavier hydrocarbons from the LNG to meet export gas BTU requirements.
2. Utilizes sub-cooling (refrigeration) available from LNG to condense high pressure methane rich stream from a very high pressure demethanizer operations requiring lower level refrigeration as well as lower latent heat requirements to condense.
3. Process can operate in high ethane recovery or ethane rejection (very low ethane recovery) mode while maintaining high propane and heavier hydrocarbons recovery from LNG.
4. Highly efficient process – No compression is utilized for high pressure gas delivery.
5. Majority of heating requirements in the process is achieved by utilizing traditional vaporization equipment at the terminals i.e. Over the Rack Vaporizers (ORV) or Submerged Combustion Vaporizers (SCV) normally utilized at the LNG terminal.
6. Reboiler heating for the demethanizer can be supplied with Submerged Combustion Vaporizer providing safe method for heat supply (when waste heat is not available). Special design for utilizing SCV's in this service.
7. There are three version of the process. One process utilizes internal condenser (dephlamator).

C_2 Plus Recovery at LNG Gasification Terminals

LNG

Capabilities & Experience

- Process designed to provide flexibility to recover NGL from LNG
- Ideal for C_2 plus recovery (mixed NGL) from LNG
- Similar type of equipment utilized
- Very little learning curve for operators

LNG

C_2 Plus Recovery at LNG Gasification Terminals

- Fuel efficient process
- Can be operated in either mode (LNG gasification or NGL recovery)
- Can be easily switched from one mode of operation to the other
- Economical
- Ideal process if NGL pipeline located in the vicinity of the terminal

Capabilities & Experience

Data Required for Economic Model

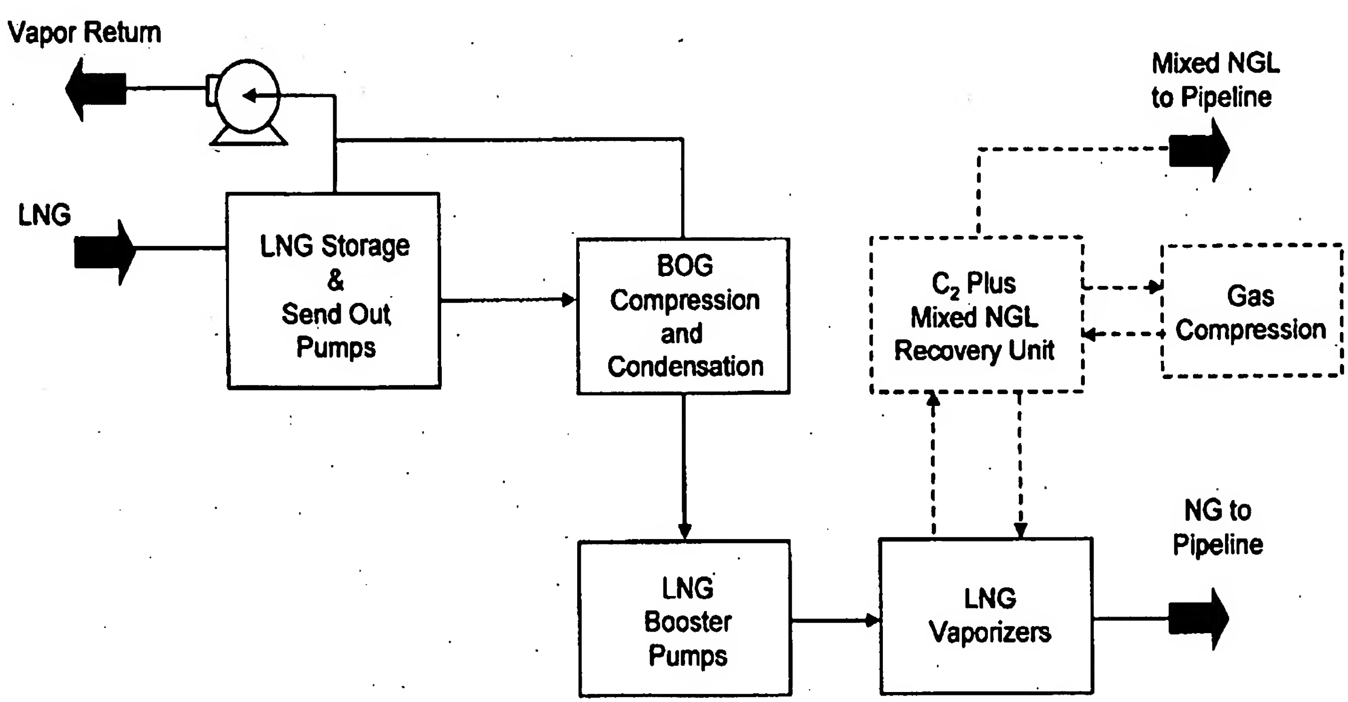
LNG

- Gas composition
- Gas value $/MMBTO
- C_2, C_3, C_4 and C_5's market value $/gal
- Electrical cost (if available)
- Any transportation cost (if pipeline transport) $/gal

Capabilities & Experience

LNG Vaporization with NGL Recovery

LNG

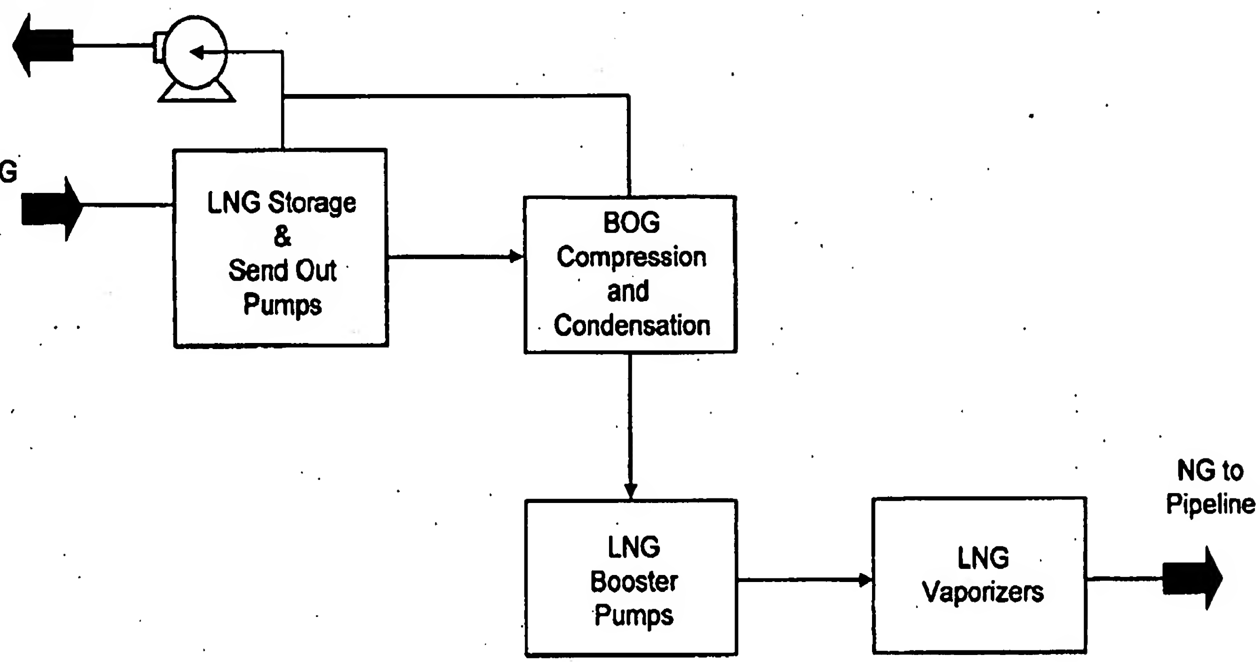


Capabilities & Experience

Aker Kvaerner

CMS LNG

Typical LNG Vaporization



C_2 plus recovery from LNG at Gassification Terminal
Abu Dhabi LNG

	TYPICAL LNG		RESIDUE & FUEL GAS		DEMETHANIZED PRODUCT				OVERALL
COMP.	MOL/HR	MOL %	MOL/HR	MOL %	MOL/HR	MOLE%	GAL/DAY	BBL/DAY	RECOVERY (%)
N_2	32.94	0.04	32.94	0.05	---	0.00	---	---	---
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0	0	---
H_2S	0.00	0.00	0.00	0.00	0.00	0.00	---	---	
C_1	71856.31	87.26	71803.95	98.17	52.36	0.57	8,064	192	---
C_2	9264.08	11.25	1296.97	1.77	7967.11	86.53	$\boxed{1,936,198}$	46,100	86.00
C_3	1037.58	1.26	6.23	0.01	1031.35	11.20	258,242	6,149	99.40
$i\text{-}C_4$	74.11	0.09	0.15	0.00	73.96	0.80	21,987	523	99.80
$n\text{-}C_4$	82.35	0.10	0.08	0.00	82.27	0.89	23,568	561	99.90
$i\text{-}C_5$	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
$n\text{-}C_5$	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
C_6	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
C_7 Plus	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
TOTAL	82347.36	100.00	73140.31	100.00	9207.05	100.00	2,248,059	53,525	
GAS VOLUME:									
MMSCFD		750.00		666.14			---		
MOL.WT.		18.06		16.30			---		
GAL/MSCF:	C2+	3.41		---					
	C3+	0.41		---					
LHV, Btu/scf		1010.53		921.69					
GHV, Btu/scf		1118.30		1023.15					
LIQUID VOLUME:									
BBL/DAY Total		---		---			53,525		
NGL -S.G.@ 60 F.		---		---			0.378		
Standard Conditions:		14.696 Psia, @ 60 deg. F.							
Notes:									

C_2 plus recovery from LNG at Gassification Terminal
Algeria Sonatrac #1 & #2 LNG

	TYPICAL LNG		RESIDUE & FUEL GAS		DEMETHANIZED PRODUCT				
COMP.	MOL/HR	MOL %	MOL/HR	MOL %	MOL/HR	MOLE%	GAL/DAY	BBL/DAY	OVERALL RECOVERY (%)
N_2	139.99	0.17	139.99	0.19	---	0.00	---	---	---
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0	0	---
H_2S	0.00	0.00	0.00	0.00	0.00	0.00	---	---	
C_1	72424.50	87.95	72373.68	98.41	50.82	0.58	7,827	186	---
C_2	7287.74	8.85	1020.28	1.39	6267.46	71.21	$\boxed{1,523,143}$	36,265	86.00
C_3	1786.94	2.17	10.72	0.01	1776.22	20.18	444,750	10,589	99.40
$i\text{-}C_4$	279.98	0.34	0.56	0.00	279.42	3.17	83,062	1,978	99.80
$n\text{-}C_4$	411.74	0.50	0.41	0.00	411.33	4.67	117,840	2,806	99.90
$i\text{-}C_5$	16.47	0.02	0.00	0.00	16.47	0.19	5,476	130	100.00
$n\text{-}C_5$	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
C_6	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
C_7 Plus	0.00	0.00	0.00	0.00	0.00	0.00	0	0	100.00
TOTAL	82347.36	100.00	73545.65	100.00	8801.71	100.00	2,182,097	51,955	
GAS VOLUME:									
MMSCFD		750.00		669.84			---		
MOL.WT.		18.28		16.27			---		
GAL/MSCF:	C2+	3.23		---					
	C3+	0.87		---					
LHV, Btu/scf		1019.30		917.74					
GHV, Btu/scf		1127.67		1018.86					
LIQUID VOLUME:									
BBL/DAY Total		---		---			51,955		
NGL -S.G.@ 60 F.		---		---			0.408		
Standard Conditions:		14.696 Psia, @ 60 deg. F.							
Notes:									